ENVIRONMENTAL CONDITIONS

WATER QUALITY

Folsom Lake State Recreation Area

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WATER QUALITY

Introduction

This section discusses water quality characteristics of Folsom Lake, Lake Natoma and the American River in the vicinity of Folsom Lake State Recreation Area (the Unit). The information contained in this section is based on several sources, as follows: 1) a review of reports, documents and environmental plans for the Unit and other projects proposed for the area, including the Regional Water Quality Control Board - RWQCB (1998), Army Corps of Engineers - ACOE (2001a and b), Surface Water Resources Inc. - SWRI (2001), Placer County Water Agency - PCWWA (2002); U.S. Geological Survey - USGS (2002), National Water Information Systems (2003); 2) site visits conducted on July 10 and October 6, 2002 to inspect areas potentially prone to water quality problems such as public beaches and camping areas; and 3) interviews with resource agency personnel familiar with the area. Agency personnel interviewed include: Peter Vonich, Brian Deason and Sandi Richerson of the BOR; Jim Micheals and Shana Avalos of the CDPR; Ken Christiansen of the Folsom Lake Marina; and Mary Taylor of the Sacramento County Department of Environmental Management. The El Dorado County Department of Environmental Management and the Placer County Department of Environmental Health were contacted but they had no pertinent water quality data. RWQCB personnel interviewed include: Rick Humphreys, Steve Rosenbaum, George Day, Pat Leary, and Richard McHenry. Charles Alpers of the USGS was interviewed regarding recent mercury studies in Lake Natoma.

Existing Water Quality

The vast majority of water entering Folsom Lake and Lake Natoma is well oxygenated, cold water of high quality. As water flows through the two lakes, it is impacted by various sources of water quality degradation that cause water quality problems. Primary water quality problems include excessive sediment inflow from development in local runoff, nutrient inflow to Alder Pond, mercury bioaccumulation in fish from abandoned mining tailings, bacterial contamination of waters heavily frequented by waterfowl, and occasional sewage spills in the watershed from wastewater treatment plants. Despite these problems, water leaving Lake Natoma remains of high enough quality to generally meet State water quality standards.

Seasonal temperature stratification processes play an important role in lake water quality conditions. Folsom Lake becomes thermally stratified each spring and maintains a separation between the warmer waters of the top layer (epilimnion) and the cold water pool comprising the bottom layer (hypolimnion). Thermal stratification begins in April, continues through the summer and holds into November when winds and inflow begin to mix the top and bottom layers. During the summer, the epilimnion temperature is typically 78 to 72 degrees F (25.5 to 22 degrees C) from the surface down to a depth of 35 feet.

A relatively broad zone of temperature change called the metalimnion or thermocline lies beneath the epilimnion. A depth of 65 feet is needed before the water temperature drops to

60 degrees F (15.5 degrees C). Near the bottom of the reservoir the summer water temperature lowers to 48 degrees F (9 degrees C). Dissolved oxygen levels in the upper warm layer were 8 mg/L in late July of 2002 and 6 mg/L at a depth of 195 feet in the hypolimnion (Brian Deason, BOR *pers. com.*).

Lake Natoma does not thermally stratify because water released into it from Folsom Lake flows through quickly to Nimbus Dam. The upper one third of Lake Natoma has a "plunge zone" defined by the cold water from Folsom Dam release moving along the bottom of the regulating reservoir. As the waters spread out over the wider portions of Lake Natoma they become warmer. Typical summer water temperatures in Lake Natoma are in the range of 58 to 70 degrees F (14.5 to 21 degrees C) (Brian Deason, BOR *pers. com.*). As in Folsom Lake, the waters of Lake Natoma are well oxygenated throughout the year.

Water releases from Folsom Lake to Lake Natoma are managed to maintain cold water temperatures in the Lower American River throughout the year. These water releases help maintain water temperatures suitable for anadromous steelhead and chinook salmon in the Lower American River below Nimbus Dam.

Several sources of water quality data were used in the following water quality discussion. These are summarized below:[1]

- ***Bureau of Reclamation Sampling Stations*** - The BOR has three water quality sampling stations in or near the Unit. These are located on the American River below Folsom Dam [Station # BS-MN-10]; on the American River at the headwaters of the South Canal, on Lake Natoma [Station # BS-MN-16]; and behind Folsom Dam at the outlet to the American River [Station # BS-MN-17]. Parameters analyzed for the quarterly water samples from these stations include fecal coliform, heavy metals, nutrients, organic priority pollutants, and a wide variety of pesticides.

  Sampling results currently available for review cover the period from February 1999 to November 2000 for the American River below Folsom Dam, and February 2001 to February 2002 for the other two stations. More recent sampling results exist, but are not yet available for public review (Peter Vonich, BOR pers. com.). Because of the extensive analyses for pesticides and Polycyclic Aromatic Hydrocarbon (PAH) compounds, the available data for 1999 through 2002 comprises 64 pages and are too lengthy to include in this document. However, results for these parameters are summarized. Analysis results for fecal coliform, nutrients, mercury, and MTBE are presented in Tables WQ-1 and WQ-2.

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[1] The ***National Water Information Systems*** (NWIS 2003) has monitoring stations located along the rivers and lakes above Folsom Lake, at the Folsom Dam, and at Nimbus Dam. However, most of the NWIS stations above Folsom Lake do not appear to be presently active and the data available from this site are 12 to 20 years out of date. For this reason, these data are not included in this section as more current water quality information has been used whenever possible.

- ***Sacramento County Department of Environmental Management Sampling Data*** - The Sacramento County Deptartment of Environmental Management conducts occasional bacteriological tests of swimming beaches in the two lakes. These data are included in Table WQ-3.

- ***Sacramento Coordinated Monitoring Program (CMP) -*** Managed by Steve Nebozuk of the Sacramento Regional Central Sanitation District, this program maintains a water quality monitoring station on the American River below Nimbus Dam. This program has monthly sample data from 1992 to the present with a large number of pesticides and PAHs included in the analyses. As with the BOR data noted above, the CMP data includes analyses for the pesticides Malathion, Chlordane, Carbofuran, Diazinon, Lindane and many others. A review of these data found no detectable levels of pesticides. The CMP data are too extensive to include in this document, but monthly readings (June 2001 through June 2002) of dissolved oxygen, water temperature, and pH are graphed in Figure WQ-1.

Ambient water quality conditions in the Lower American River below Nimbus Dam generally meet applicable regulatory standards as set forth in the Water Quality Control Plan ("Basin Plan") for the Central Valley Region (RWQCB 1998). Concentrations of contaminants typically increase downstream from Nimbus Dam to the Sacramento River as the river receives runoff from more urbanized drainages (SWRI 2001). Folsom Lake, Lake Natoma and the American River, down to the Sacramento River, are recognized in the RWQCB Basin Plan as water bodies that provide a series of "beneficial uses" to the public. These beneficial uses must be taken into consideration when establishing water quality objectives and evaluating impacts of any proposed activity on water quality. The beneficial uses specifically provided by Folsom Lake and Lake Natoma are the following:

- municipal and domestic water supply;
- irrigation water for agriculture;
- hydropower;
- water contact recreation;
- non-contact water recreation;
- warm water freshwater habitat;
- cold water freshwater habitat;
- fish spawning; and
- wildlife habitat.

Under the Basin Plan, the State of California defines specific water quality objectives that should be attained in order to protect and maintain the beneficial uses of Folsom Lake, Lake Natoma and the American River downstream. Discussed below are the key water quality objectives for these systems and what is currently known about existing conditions relating to each of these objectives.

Table WQ-1: Selected Water Quality Parameters from BOR Sampling Stations between Folsom Lake and Nimbus Dam

American River below Folsom Dam		Date of Sampling							
(Station # BS-MN-10)	Units	2/16/99	5/18/99	8/24/99	11/8/99	3/6/00	5/15/00	8/16/00	11/7/00
Fecal Coliform	MPN/100mL	80	7	50	1600	270	>1600	50	6
Nitrate & Nitrite as N	mg/L	0.180	0.056	<0.100	0.220	0.120	0.230	<0.050	<0.050
Total Phosphorus as P	mg/L	<0.050	<0.050	<0.100	<0.100	0.013	0.070	0.029	0.011
Tot. Dissolved Solids	mg/L	46	49	20	50	53	91	31	40
Mercury (dissolved)	ug/mL	0.006	<0.01	<0.01	<0.01	0.011	0.013	<0.005	<0.005
MTBE	ug/mL	ND	<0.5	---	<0.5	<0.5	<0.5	<0.5	<0.5
Headwaters of South Canal at		**Date of Sampling**							
Lake Natoma (Station # BS-MN-16)	**Units**	**2/27/01**	**5/17/01**	**8/6/01**	**11/5/01**	**2/13/02**			
Fecal Coliform	MPN/100mL	27	300	30	4	14			
Nitrate & Nitrite as N	mg/L	0.060	<0.050	<0.050	<0.050	0.080			
Total Phosphorus as P	mg/L	0.025	0.029	<0.010	<0.010	0.180			
Tot. Dissolved Solids	mg/L	36	36	34	39	38			
Mercury (dissolved)	ug/mL	<0.005	<0.005	<0.005	<0.005	<0.005			
MTBE	ug/mL	<3	<3	<3	<3	<3			
Behind Folsom Dam at Outlet		**Date of Sampling**							
(Station # BS-MN-17)	**Units**	**2/27/01**	**5/17/01**	**8/6/01**	**11/5/01**	**2/13/02**			
Fecal Coliform	MPN/100mL	30	4	2	8	17			
Nitrate & Nitrite as N	mg/L	<0.050	<0.050	<0.050	<0.050	0.110			
Total Phosphorus as P	mg/L	<0.010	<0.010	0.014	0.022	<0.050			
Tot. Dissolved Solids	mg/L	39	41	43	42	44			
Mercury (dissolved)	ug/mL	<0.005	<0.005	<0.005	0.0074	<0.005			
MTBE	ug/mL	---	---	---	---	---			

Source: Peter Vonich, BOR at Folsom Dam

Table WQ-2: Fecal Coliform Bacteria Levels in Lake Natoma and Folsom Lake, 2002 BOR Sampling

Table WQ-2. Fecal Coliform Bacteria Levels in Lake Natoma and Folsom Lake, 2002 BOR Sampling																
	Fecal Coliform Concentrations in MPN/100 mL															
	Lake Natoma														Folsom Lake	
Sampling Date	Aquatic Center	Aquatic Center Dock	Willow Creek	Willow Creek Channel	Negro Bar	Negro Bar Boat Ramp	Nimbus Flat	Nimbus Flat Boat	Alder Creek	Parkshore	Folsom South Canal	Peninsula	Nimbus Buoy Line	Mississippi Bar	Granite Bay	Beals Point
7/24/02	>1600		23												8	280
7/29/02	240		130												22	300
8/5/02	300		110												13.37	<2
8/12/02	300		220												22	11
8/19/02	300		30												11	4
9/3/02	240		50												7.4	130
9/9/02	240			23	23							2				
9/16/02	11			14	30		7		4	2						
9/23/02	500	80					50				30		23	130		
9/24/02					13											
9/25/02				30		70		23								
9/26/02	2			170		30										
9/30/02	13	17					23	11								
10/7/02	27		30		17		50									
10/15/02	50															
10/21/02	30		30													
10/28/02	4		50													
11/8/02	130		>1600	>1600	>1600		80		220							

Note: The September 24 - 26, 2002 samplings were in response to a sewage spill at Folsom Prison.
The high values (>1600) on November 8, 2002 were associated with a storm event following 167 days of no rain.

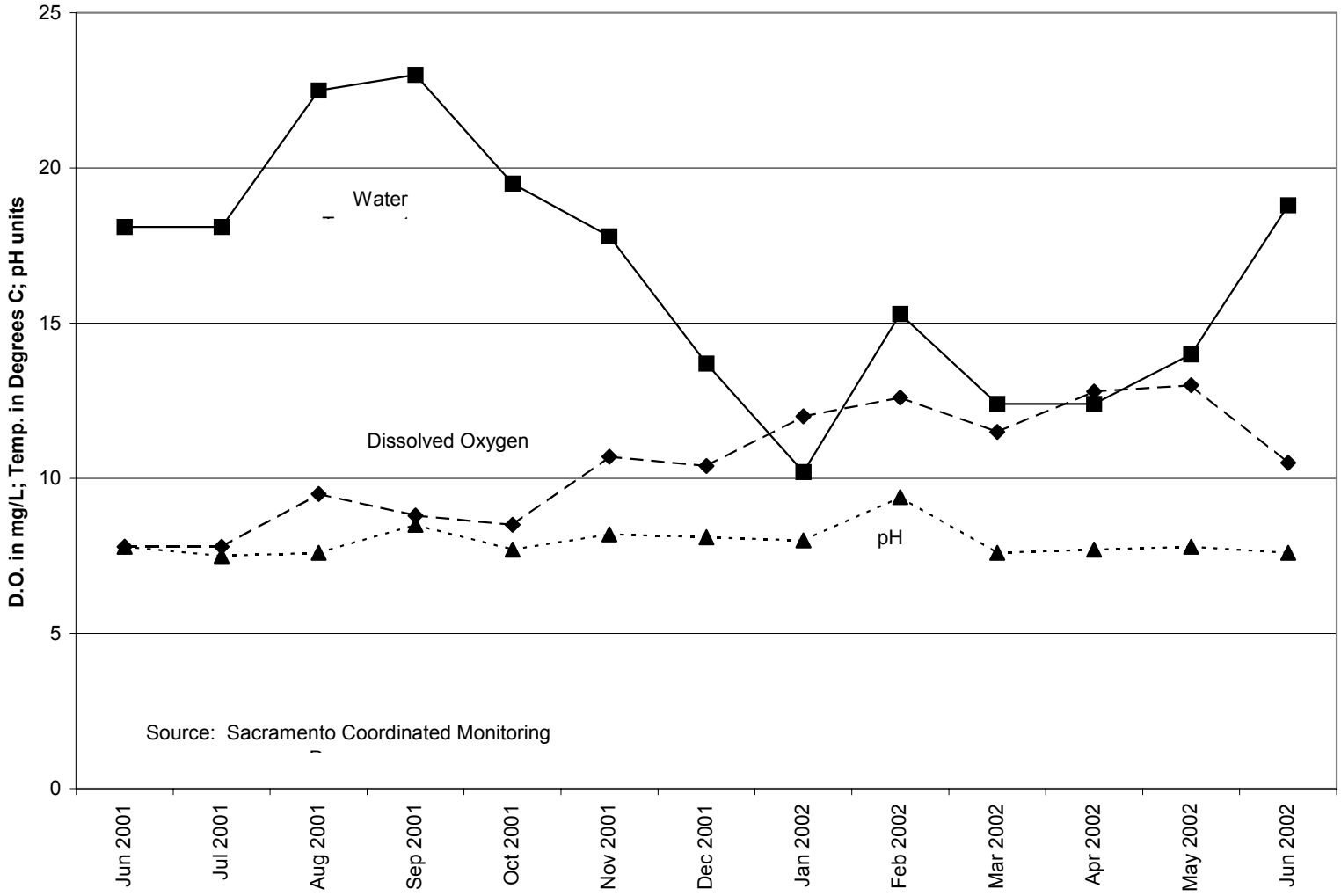
Source: Brian Deason at the U.S. Bureau of Reclamation, Folsom Dam

Table WQ-3: Bacteria Levels at Swim Beaches Folsom Lake SRA Sacramento County Sampling Data

Sampling Location	Sample Date	Fecal Coliform (MPN/100 mL)	Total Coliform (MPN/100 mL)	Enterococcus (MPN/100 mL)
		Alert Level: 400 MPN/100 mL	Alert Level: 10,000 MPN/100 mL	Alert Level: 61 MPN/100 mL
Folsom Lake at Folsom Point (Dike 8)	6/28/02	14	300	1
Lake Natoma (upper) at Folsom Landing	7/12/02	50	80	2
Lake Natoma (upper) at Folsom Landing	9/25/02	23	300	Not Taken
Lake Natoma (upper) at Folsom Landing	9/25/02	70	280	Not Taken
Lake Natoma (lower) at Aquatic Center	7/12/02	170	300	17
Lake Natoma (lower) at Aquatic Center	9/25/02	23	300	Not Taken
Lake Natoma (lower) at Aquatic Center	9/25/02	70	280	Not Taken

Source: Sacramento County Department of Environmental Management

Figure WQ-1: Dissolved Oxygen, Temperature, and pH, Lower American River below Nimbus Dam, June 2001 to June 2002



Temperature

The Basin Plan states that the natural receiving water temperature of waters shall not be altered in a manner that adversely affects beneficial uses. Releases from Folsom Lake Dam and Nimbus Dam are managed so that water temperatures in Nimbus Lake and the American River downstream favor the specific beneficial uses of maintaining cold water freshwater habitat and fish spawning habitat. Recommendations regarding the operation of these dams are made through the American River Operation Group (AROG), a collaborative group of stakeholders. The primary goal of AROG is to make recommendations on how to balance the operation of the dams while considering the cold water needs of the anadromous salmonid fisheries in the Lower American River below Nimbus Dam (Jim Micheaels, Gold Fields District DPR *pers. com.*).

As noted above, water temperatures in Folsom Lake are largely a consequence of seasonal water stratification. The temperature of water releases from Folsom Dam depends on whether the water released is from the cold hypolimnion, the moderate thermocline layer, or the warm epilimnion. Water releases from Folsom Lake's hypolimnion are in the temperature range of 48 – 60 degrees F (9.0 – 15.5 degrees C).

Water releases from Folsom Lake pass too quickly through Lake Natoma to allow this afterbay to thermally stratify. The cold water gradually warms as it spreads over the wider portions of the Lake Natoma. Figure WQ-1 shows monthly temperatures for the water discharged from Nimbus Dam into the Lower American River in 2001 and 2002. To allow dissolved oxygen and pH to be plotted on the same graph as water temperature, the temperature is shown in degrees C. The lowest temperatures are in March and April with 12.4 degrees C (54.5 degrees F). June and July temperatures are a little over 18.0 degrees C (64 degrees F), and the warmest temperatures occur in August and September where it tops out at 23 degrees C (73 degrees F). The August and September temperatures likely reflect the period when most of the hypolimnion waters had been expended.

Nimbus hatchery, which raises steelhead and chinook salmon, draws its water from Lake Natoma. During late summer, Lake Natoma's water to the hatchery sometimes fails to meet the hatchery's requirement of water not exceeding 60 degrees F (15.5 degrees C). By prolonging the release of cold water from the hypolimnion of Folsom Lake throughout the summer and early fall, Lake Natoma water are more likely to meet the hatchery requirements. Cold water releases from Nimbus Dam to the Lower American River must also remain sufficiently cool to avoid stressing the juvenile steelhead rearing in the river and the adult Chinook salmon migrating up the river to spawn.

Bacteria

Regarding bacteria objectives, the Basin Plan specifically assigns Folsom Lake fecal coliform bacteria standards that are twice as stringent as other waters in the region that are designated for water contact recreation. The Basin Plan states:

> For Folsom Lake, the fecal coliform concentration based on a minimum of not less than five samples for any 30-day period, shall not exceed a geometric mean of 100

Most Probable Number (MPN)/100 ml, or shall more than 10 percent of the total number of samples taken during any 30-day period exceed 200/100 ml.

Table WQ-1 presents fecal coliform bacteria levels for a variety of months in 1999 through early 2002 for three sampling stations. None of the samples from Folsom Lake at the dam had fecal coliform levels in excess of the above water quality objective. However, the American River below Folsom Dam exceeded the management goal of 100 MPN/100 mL in November 1999, March 2000, and May 2000. The headwaters of the South Canal at Lake Natoma exceeded the fecal coliform bacteria objective in May 2001. Additional fecal coliform bacteria data associated with swim beaches and areas of heavy waterfowl use is provided later in this section.

Dissolved Oxygen

The Basin Plan states that the monthly median of mean daily dissolved oxygen concentration shall not fall below 85 percent of saturation in the main water mass, and the 95 percentile concentration shall not fall below 75 percent of saturation. The dissolved oxygen concentrations shall not be reduced below 7.0 mg/L at any time in waters with cold water fishery and fish spawning beneficial uses.

Although, only limited dissolved oxygen data is available for the two lakes, it would appear that both lakes are well oxygenated throughout the year, and that these standards are probably met. For example, dissolved oxygen levels in the upper warm layer were 8 mg/L in late July of 2002 and 6 mg/L at a depth of 195 feet in the hypolimnion (Brian Deason, BOR pers. com.). Table WQ-1 displays the dissolved oxygen levels for the Lower American River directly below Nimbus Dam. All readings are greater than 7.0 mg/L with the lowest readings occurring in June and July 2001. The highest reading was 13 mg/L and the median reading was 10.5 mg/L.

pH

The Basin Plan states that pH shall not be depressed below 6.5 nor raised above 8.5. Changes in normal ambient pH levels shall not exceed .05 in fresh waters designated for cold water fisheries beneficial uses.

Table WQ-1 presents monthly pH values for the discharge from Nimbus Dam for 13 months in 2001 and 2002. The pH values range from 7.5 to 9.4. The value of 9.4 is an outlyer and may be an error, as the second highest pH value is 8.5. The median pH value for the 13-month period was 7.7.

Oil and Grease

The Basin Plan states that waters shall not contain oils, greases, waxes, or other materials in concentrations that cause nuisance, result in a visible film or coating on the surface of the water or on objects in the water, or otherwise adversely affect beneficial uses.

There are three primary sources of oil and grease entering the waters of Folsom Lake and Lake Natoma. Urban runoff from the developed watershed around portions of the two lakes are a primary source of petroleum residue that enters the storm drain system and discharge into local drainages to the lakes. A second source of petroleum products is the storm drains

for the marina and day use facility parking lots and adjacent roads. Petroleum residues build up on these surfaces during the dry season. The first substantial storm event of the fall/winter season typically carries the highest load of oil and grease residue into the storm drains and ultimately into the two lakes (Varanasi 1989). The third source is related to motor boat activities on the lake. Spilled gasoline associated with filling fuel tanks while on or adjacent to the lake, plus the pumping of bilge water while boating on the lake, can be a significant source of petroleum on waters with heavy boating use.

Petroleum-based oil and grease are hydrophobic (repel water) and leave a film on the surface of the water. Also known as "Polycyclic Aromatic Hydrocarbons" or PAHs, their hydrophobic nature cause them to rapidly attach to suspended sediments and ultimately be deposited on the lake bottom (Varanasi 1989). Examples of PAH compounds often included in water testing are: Naphthalene, Fluorene, Dibenzothiophene, Phenanthrene, Fluoranthene, Pyrene, and Chrysene. Both the BOR and Sacramento CMP water analyses for the stations previously described include a large number of PAH compounds. Although this data set is too large to include in this document, a review of these data sets rarely shows a PAH compound at detectable levels.

Total Dissolved Solids

The Basin Plan states that total dissolved solids in Folsom Lake shall not exceed 100 mg/L (90 percentile).

Table WQ-1 presents total dissolved solids (TDS) data for three locations between Folsom Lake and Nimbus Dam. The highest TDS value recorded for this data set is 91 mg/L and the lowest is 20 mg/L. The majority of the TDS readings are between 36 and 50 mg/L.

Turbidity

The Basin Plan requires that turbidity shall be less than or equal to 10 Nephelometric Turbidity Units (NTUs) in Folsom Lake and the American River (Folsom Dam to Sacramento River), except for periods of storm runoff,

The Sacramento CMP data for the Lower American River immediately below Nimbus Dam includes turbidity readings. A review of the monthly data set from January 2001 through June 2002 for this site shows turbidity readings ranging from 0.5 NTU to 5.0 NTU with most of the readings between 1.0 NTU and 4.0 NTU, well within the Basin Plan objectives.

Sources of Water Quality Problems

This section discusses known or potential sources of water quality problems in the Unit.

Storm Water Runoff

In the past, water quality impacts from storm water runoff have not been a major concern for Folsom Lake and Lake Natoma. The primary water sources for the two lakes (the South and North Forks of the American River) contribute huge volumes of water from undeveloped watersheds. At one time, the relatively small volume of local runoff originated from

watershed lands with only a modest level of urbanization. However, over the past two decades, the local watershed for both lakes has become increasingly urbanized and the urbanization process is continuing apace. As a consequence, the water quality of local runoff has almost certainly decreased while the volume and rate has increased with increased amounts of impervious surface.

Storm water runoff associated with housing, roads, and commercial development within the nearby watershed are sources of sediment and petroleum residue. Other contaminants commonly associated with street and parking lot storm water runoff are lead, zinc, nutrients from adjacent fertilized landscaping, and bacteria from dog waste (Wanielista and Yousef 1992). Storm water runoff from lawns at day-use areas within the Unit can be a source of bacteria from the waste materials of dogs and waterfowl, particularly geese.

The Georgetown Divide Resource Conservation District (GDRCD) recently completed a watershed assessment for the South Fork of the American River Watershed in which sedimentation and fuels management were identified as the primary resource concerns within the watershed. Sub-basins located in the foothill zone of the watershed (nearest the Unit) were identified as having the greatest potential to experience adverse water quality effects associated with sedimentation, including the New York, Kelley, Big Sailor and Webber Creek sub-basins (GDRCD, 2003). Furthermore, the RWQCB believes that a reduction in sediment loads from local runoff to Folsom Lake and Lake Natoma would help reduce concentrations of other urban runoff pollutants of concern. Therefore, sediment management in the local watershed is a primary concern to the RWQCB (George Day, RWQCB Storm Water Unit *pers. com.*).

The most visible example of sediment problems associated with local runoff occurs at the Folsom Lake Marina at the mouth of Brown's Ravine. Development in the Brown's Ravine watershed and adjacent watersheds that are drained by several ephemeral streams into the Folsom Lake Marina area has resulted in sediment problems during most storm events (Ken Christiansen, Folsom Lake Marina Manager pers. com.). The recent widening of Green Valley Road has resulted in the replacement of the older 12-inch culverts with 3-foot and 4-foot culverts to accommodate increased stormflow resulting from impervious surface associated with development in the watershed. Unfortunately, drainpipes near the Marina are still 12-inches in diameter and are too small to accommodate this increased storm water runoff. During most storm events, much of the runoff in an ephemeral drainage overflows its culvert and flows across the Marina parking lot. Following storm events, this parking lot is covered with sediment and debris that must be removed by CDPR staff. There are also four ephemeral streams that overflow culverts and cross the main entrance road to the Marina. One of these sites of overflow exhibits severe erosion near the culvert.

The primary drainage into the Folsom Lake Marina is through Brown's Ravine. The high sediment load now carried by Brown's Ravine because of upstream development has added approximately 1.5 feet of sediment to the Marina basin in the vicinity of the docks. It has also resulted in the waters of the Marina basin being especially turbid (Ken Christiansen, Folsom Lake Marina Manager pers. com.). There appears to be no water quality data that quantifies the pollutant load of storm drain contaminants entering Folsom Lake and Lake Natoma (George Day, RWQCB Storm Water Unit *pers. com.*) through Brown's Ravine.

The City of Folsom uses the Sacramento County standards for erosion and sediment control and has a number of sediment and storm water retention basins in place (Daron Wilson, City of Folsom Planning Dept. Engineer *pers. com*.). Development and road widening projects in the Brown's Ravine area are located in El Dorado County. El Dorado County employs Best Management Practices (BMPs) to minimize sediment and erosion associated with construction activities.

Interviews with various BOR, RWQCB, and County (Placer, El Dorado, and Sacramento counties) water quality and public health specialists revealed that almost no monitoring of storm water from local drainages is conducted. However, some testing for nutrients in Alder Creek waters at Alder Pond adjacent to Lake Natoma have been performed (Sandi Richerson, BOR *pers. com*.). The testing of Alder Pond waters resulted from concern regarding nutrient input to Alder Pond from the nearby auto mall car washing operations that may affect the growth of aquatic weeds and algae.

Alder Creek Pond is an isolated component of the Lake Natoma drainage located on the south side of Hwy 50. Culverts under Hwy 50 connect this still-water portion of Alder Creek with Lake Natoma. Alder Creek Pond has a history of water quality problems manifested as excessive growths of water hyacinth or algae, accompanied by high levels of biochemical oxygen demand and depressed levels of dissolved oxygen. Nutrient enrichment from the local watershed is suspected as a contributor to this problem (Charles Alpers, USGS *pers. com.*).

Nutrient testing of two Alder Pond water samples collected in January 2002 found total phosphorus levels of 0.036 mg/L and 0.053 mg/L. The BOR considers "fair" protection from nuisance aquatic plant growth to range from 0.030 mg/L to 0.049 mg/L, and "poor" protection to range from 0.050 mg/L to 0.149 mg/L. These sample samples had total nitrogen levels of 0.71 mg/l and 1.01 mg/L, which are also sufficiently high to encourage nuisance plant growth. These Alder Pond testing results are reported in a letter from BOR Area Manager, Thomas Aiken to Peter Piccardo of the City of Folsom (Aiken, 2002). The letter states that the large population of water hyacinth in Alder Pond is not a natural occurrence but is induced by high nutrient loading.

Alder Pond is scheduled for restoration under the U.S. Army Corps of Engineers' Aquatic Restoration Program if a non-Federal sponsor can be found (Sandi Richerson, BOR *pers. com.*). Restoration would manage the pond for its wildlife values and would install a gate system to provide greater flexibility in managing water levels in Alder Pond. Currently the water levels rise and fall with the water level in Lake Natoma.

Water Quality Impacts from Boating Activities

The Unit is served by the Folsom Lake Marina and five other boat launch facilities around the lake. Motor boats and two-stroke engines are allowed on Folsom Lake. Lake Natoma allows motor boats upstream of Willow Creek (max. speed of 5 mph) but not downstream toward Nimbus Dam. There is a paved boat launch ramp for boats without gasoline engines at the Aquatic Center near Nimbus Dam. A gravel launch ramp is provided for power boats at the mouth of Willow Creek.

Bilge Program - At Folsom Lake, boating facilities as well as camping and day use facilities adjacent to the Lake include parking lots from which storm water runoff drains into the Lake. Petroleum residue (oil and grease) builds up in these parking lots during the dry season and is

flushed into the lake with the first substantial rain of the fall/winter. The Folsom Lake Marina and boat launch areas are also potential sources for spilled petroleum products. However, for the past three years the Unit has implemented a Bilge Program to minimize spilled petroleum products (Shana Avalos, Gold Fields District DPR Interpreter *pers. com.*). Boaters at the Folsom Lake Marina are encouraged to maintain a kit consisting of absorbent pads for small spills, a funnel to facilitate gasoline transfer to outboard and inboard motors, a sponge to be placed in the bilge, and a bucket in which to transport the soiled rags and sponge. The soiled rags and sponge can be disposed of at the Marina. Brochures on the program are distributed at the Marina and other park facilities to educate the public to the problem and the availability of the kit. Petroleum spills have not been a problem at the Marina in recent years (Ken Christiansen, Folsom Lake Marina Manager *pers. com.*).

Pump-it-Out Program - Another program aimed at boaters is the "Pump-it-Out" program (Shana Avalos, Gold Fields District DPR Interpreter *pers. com.*). Brochures are distributed to boaters alerting them to boat holding tanks pump-out facilities at the Folsom Lake Marina. As part of this program designed to eliminate Unit users' wastewater from entering the lakes, public restrooms are distributed along the shoreline of Folsom Lake and Lake Natoma. Folsom Lake also has two floating restrooms located at New York Cove and Anderson Island.

A 2002 season survey by the City of Sacramento Dept. of Public Utilities interviewed 53 individuals at Folsom Lake to determine awareness of the Pump-Out and restrooms program (Jason Lee, City Dept. of Public Works *pers. com.*). Of the 53 people interviewed, 47 percent had received information on the program, but only 11 percent were knowledgeable about the program. Forty one of the people interviewed owned boats and of this number, seven boat owners had holding tanks. Four of the seven boat owners with holding tanks used pump-out stations. Thirty five of the 41 boat owners used the restrooms facilities around Folsom Lake, and 11 of the 12 individuals without boats used the restrooms.

MTBE

Based on water quality studies in Shasta Lake, it is likely that the extensive use of two-stroke engines have resulted in measurable quantities of the gasoline additive, MTBE, in Folsom Lake (George Day, RWQCB Storm water Unit *pers. com*.). However, the BOR's analyses for MTBE (five to seven occasions for two sites in the vicinity of the Unit) found no detectable levels of MTBE (see Table WQ-1). While MTBE in lakes is a general concern, there is currently no plan to prohibit the use of two-stroke engines on Folsom Lake.

Water Quality Impacts at Swimming Beaches

Based on interviews with the Environmental Health Departments of Sacramento, Placer and El Dorado Counties, and with Pat Leary of the RWQCB, there has been only minimal bacteriological testing of swimming beaches in the Unit. The Sacramento County Department of Environmental Management occasionally conducts bacterial testing of Folsom Lake and Lake Natoma in response to complaints (Mary Taylor, *pers. com.*) and in 2002 collected samples for bacterial testing at two Lake Natoma sites and one site on Folsom Lake (Table WQ-3). In 2002, the BOR also conducted bacterial testing of several Lake Natoma sites and two Folsom Lake swimming beaches (Sandi Richerson, BOR *pers. com.*). The BOR data are provided in Table WQ-2.

Data in Table WQ-3 show no exceedence of the Sacramento County alert level (400 MPN/100 mL) for fecal coliform bacteria. However BOR sampling data (Table WQ-2) indicate that the alert level was exceeded several times in 2002. At the Lake Natoma Aquatic Center a level of >1,600 MPN/100mL was detected on July 24, 2002, and a level of 500 MPN/100mL was detected on September 23, 2002. A similar exceedence (> 1600 MPN/100 mL) was found on November 8 at Willow Creek, Willow Creek channel, and Negro Bar. These high levels of fecal coliform bacteria occurred during the first significant storm event of the rainy season (Table WQ-2).

The Basin Plan objective for Folsom Lake coliform bacterial levels is that the geometric mean of 5 samples collected over a 30-day period should not exceed 100MPN/100mL. BOR sampling data in Table WQ-2 indicate that fecal coliform levels may have exceeded this Basin Plan objective at the Lake Natoma Aquatics Center where 8 of 9 samples collected over a 2-month period exceeded 100MPN/100mL (from July 24-September 23, 2002 –Table WQ-2).

Occasionally, the messy diapers of small children wading in the shallows contributes to bacterial contamination at swimming beaches. Storm water runoff from parking lots and nearby camping facilities may also carry pet and animal waste into the lake near swim beaches, particularly with the first rains of the fall season. However, more commonly the source of most fecal coliform input to swimming areas is waterfowl, both domesticated and wild that frequent the beaches looking for handouts. At present, the numbers of geese and other waterfowl appear not to be a problem at the beaches on Folsom Lake. However, large numbers of geese are present on Lake Natoma (Jim Micheaels, Gold Fields District DPR, *pers. com.*). Geese may be a major contributor to the fecal coliform levels at Nimbus Flat, Negro Bar, and the confluence of Willow Creek

Sewage Spills

Approximately three years ago, Lake Natoma was the recipient of a sewage spill from the City of Folsom via Hinkle Creek. The spill was not reported until 48 hours after the event. Testing at that time revealed bacteria concentrations to be within acceptable levels (Peter Vonich, BOR *pers. com.*). Recently Folsom Prison had a sewage spill that failed to enter Lake Natoma. Sewage spills such as these can temporarily raise fecal coliform bacteria to levels hazardous to human health. Fish kills can occur if the spill includes a large volume of organic materials that can quickly lower dissolved oxygen levels. High levels of unionized ammonia used for sewage treatment may be sufficient to cause a fish kill.

In recent years, wastewater facilities operated by the El Dorado Irrigation District (EID) in El Dorado County have greatly reduced the number of spills that enter waterways draining into Folsom Lake (Richard McHenry, SWRCB NPDES Section *pers. com.*). The EID wastewater treatment plant with drainages closest to Folsom Lake is the El Dorado Hills facility. Placer County has a wastewater treatment facility just above Granite Bay, and the City of Auburn has treatment facilities whose spills may eventually drain into the North Fork American River. When wastewater treatment plant spills occur, follow-up testing of the waters of Folsom Lake is rare. Unit personnel are often not notified of the occurrence of some of these spills (Richard McHenry, SWRCB NPDES Section *pers. com.*). In most cases, the volume of water in Folsom Lake and Lake Natoma will quickly dilute the spill to safe bacterial levels. However, Unit personnel should be notified of every sewage spill through either the

Office of Emergency Service or the county environmental health department with jurisdiction over the wastewater treatment facility.

Water Quality Problems from Abandoned Mine Waste

A history of gold mining in the area, and the use of mercury to process gold-bearing ore appears to be the cause of relatively high levels of mercury in Lake Natoma fishes. Researchers recently found that more than half of the 22 sampled fish contained mercury in concentrations above the federal EPA's "screening level" (0.3 ppm), warranting further testing. Bass more than one-foot long contained mercury at levels that trigger state advisories (Bowman 2002). The sampled fish were captured at the mouths of the once heavily mined Willow and Alder Creeks and a small inlet on the east side of the lake (Bowman 2002). The Folsom area had one of the largest gold-dredging operations in California. Operators of the giant floating dredgers coated the sluices with mercury to amalgamate the gold particles, occasionally spilling the mercury into the surrounding environment.

Mercury can exist in many forms, most of which are stable and unavailable for biological uptake. However, inorganic mercury can be methylated by microbes and fungi into an organic form known as methyl-mercury (Baudo et al 1990; Domagalski et al 2000). Fish take in some methyl-mercury through their gills, but most of their intake is through their food. Once consumed by fish, methyl-mercury is retained in the fatty tissue and bioaccumulates so that older and larger fish contain a higher concentration of methyl-mercury than younger or smaller fish. Fish that predate on other fish tend to have higher concentrations of methyl-mercury than fish feeding at lower levels of the food chain. Humans who consume these fish are vulnerable to bioaccumulating methyl-mercury at levels potentially harmful to health. Methyl-mercury mainly attacks the nervous system causing loss of sensation in the extremities, tiredness, and blurred vision (OEHHA 2002). The California Department of Health Services (undated brochure) recommends that pregnant and breast-feeding women eat no more than 0.5 pounds (uncooked weight) of fish per week from freshwater sources in California. Children less than 6 years old are recommended to eat no more than 3 ounces of freshwater fish per week.

Funded by the BOR, the U.S. Geological Survey collected additional fish in September and October 2002 from the mouth of Alder and Willow creeks, plus Mississippi Bar and Negro Bar. The fillets from the fish, mostly bass and bluegill, will be tested for mercury and methyl-mercury content. With the approval of further funding from state or federal agencies, an investigation of mercury levels in water, sediment, and biota will be conducted by the U.S. Geological Survey and the University of California, Davis. The sampling program will begin in the spring of 2003 and will include sampling in the fall of 2003 (Charles Alpers, USGS, pers. com.). The objective of the investigation is to evaluate mercury and methyl-mercury concentration and loads in the Willow Creek and Alder Creek watershed. Humbug Creek, a tributary to Willow Creek, will also be included in the sampling program. Small fishes and aquatic macroinvertebrates will be used as bioindicators of mercury exposure because they have a limited range of movement and are indicative of localized exposure conditions (USGS 2002).

Testing of fish tissue for mercury content in Folsom Lake in the late 1980s indicated that fish occurring in association with known mining tailings throughout the lake are likely to have some degree of elevated mercury levels (Rick Humphreys, SWRCB, Abandoned Mines

Geologist, pers. comm..). Old mine tailings occur at Morman Island, Rattlesnake Crossing, and Pilot Creek, and the sediments below the Salmon Falls Bridge are known to have elevated mercury levels. Because not all fish in Folsom Lake inhabit areas of old mine tailings, elevated mercury in sport fish appears not to be widespread throughout the lake. At present, there has been insufficient testing to determine if mercury contamination in Folsom Lake fishes warrants concern.

There are abandoned chromate mines on the Peninsular between the North and South Fork arms of Folsom Lake. No active mines exist there. Chromium in several chemical states may occur in the environment, however, most of these chemical states are relatively non-toxic. The most toxic forms of chromium to aquatic life are trivalent and hexavalent chromium (EPA 1973). However, there is a great range of sensitivity to chromium between aquatic species and waters of different hardness. Chromium toxicity is less of a concern than methyl-mercury because chromium does not bioaccumulate in fish tissue as does mercury, and thereby is not likely to be a public health hazard (Rick Humphreys, SWRCB, Abandoned Mines Geologist, *pers. comm.*). There appears to be no data for chromium levels in sediment, water, or fish from the vicinity of Folsom Lake drainages.

Recommendations

Water Quality Database Coordination

There are presently identified two sources of scheduled water quality sampling and analyses data pertinent to the Unit: the BOR and the Sacramento Coordinated Water Quality Monitoring Program (CMP). It appears that the water quality data developed by these two sampling programs are not automatically shared between them. The data from these two sampling programs, plus the periodic bacteria sampling conducted by the Sacramento County Department of Environmental Management, are valuable for anyone managing or monitoring the quality of water in the Unit. Development of a program for storing these data in a central database is recommended. At a minimum, a program manager for the Gold Fields District of CDPR should be notified of sampling events and analyses and methods for accessing the resulting data.

Because nearly all the water in the Unit is held within reservoirs, other water quality factors should be considered that are not reported in regular hydrologic sources. Factors such as temperature stratification, possible occurrence of anoxic events in backwater areas, and contamination from adjacent land uses and waterfowl are relevant to understanding the water quality characteristics of Folsom Lake and Lake Natoma.

Bacteriological Monitoring

The Basin Plan standards for fecal coliform bacteria levels in Folsom Lake and the waters downstream of Folsom Dam are twice as stringent as for most other waters with water contact recreation. It is assumed that this is due to the heavy use of these waters by swimmers and water skiers. Sources of potential contamination and human exposure include: diapered children at swimming beaches, illegal flushing of boat holding tanks, concentrations of waterfowl near swim areas, dog droppings at picnic areas that can be washed into the lake during storm events, and sewage spills from the treatment plants for the City of Folsom and the Folsom State Prison. At present no regular monitoring of fecal coliform levels by any state or county public health agencies occurs. Currently, Unit staff are not routinely notified when when sewage spills occur in the Folsom Lake and Lake Natoma watersheds.

Coordination between the Gold Fields District of the CDPR, the BOR and state and county public health agencies is recommended to develop the following programs for monitoring fecal coliform bacteria levels in the Unit.

Monitoring Fecal Coliform Levels at Swim Beaches

To ensure that swim beaches meet Basin Plan standards for bacteria, several of the most heavily used swim beaches in Folsom Lake and Lake Natoma should be selected for twice-monthly testing of fecal coliform levels between Memorial Day weekend and Labor Day weekend. The July sampling should be scheduled to include the 4th of July holiday weekend. Sampling would probably have to occur on the last day of major holidays and on Sundays of regular weekends due to the eight-hour holding time required for fecal coliform tests. Suggested sites include Granite Bay, Beals Point, Peninsula, and Negro Bar. For those sites where waterfowl are typically present, sampling should be accompanied by a rough count of the number of geese and ducks present. Consideration should be given to the value and

feasibility of using random throws of a 1-meter quadrat to count waterfowl droppings on the lawn areas as a means of estimating the extent of waterfowl use in an area.

Quarterly Monitoring on Lake Natoma near Sewage Treatment Plants

Sewage treatment plants for the City of Folsom and the Folsom State Prison have the potential for spilling sewage into Lake Natoma. Quarterly monitoring of fecal coliform levels at points of potential discharge into the lake will establish baseline conditions and determine if low level leakage is occurring.

Memorandum of Agreement

The CDPR should develop a Memorandum of Understanding with either the Office of Emergency Service or the three counties' environmental health departments to ensure that Unit personnel are notified of every sewage spill within Unit watersheds.

Establish a Rapid Response Team for Spill Events

There should be coordination with the Sacramento County Dept. of Environmental Management, the City of Folsom Sewage Treatment Facility, and the Folsom State Prison Sewage Treatment Facility to establish a rapid response team in the event of a sewage spill. Procedures for spill notification and sampling protocols and responsibilities need to be developed so that fecal coliform and E.c*oli* testing can be conducted at specified locations in a timely manner should a spill occur.

Methylmercury Monitoring

In addition to public health concerns regarding bacteria levels, a second concern is the levels of methyl-mercury in the fish of Lake Natoma. It has not yet been determined if the levels of mercury in fish tissue warrant a public threat sufficient to warn anglers to limit their consumption of fish from Lake Natoma. Continued coordination with the USGS in its current study of mercury levels in Lake Natoma fish is recommended.

State Park and Recreation Participation in Alder Creek Pond Restoration

The future of Alder Creek Pond, a persistent trouble spot for water hyacinth, algae, and water quality, is now being evaluated by the Alder Creek Coalition, the U.S. Army Corps of Engineers, and other agencies. CDPR staff should assign a representative to participate in the U.S. Army Corps of Engineers process for planning the restoration of Alder Pond.

Upgrading of Storm Drain System – Folsom Lake Marina

The storm drain and culvert system along the main entry road to the Folsom Lake Marina and at the Marina parking lot are substantially undersized for handling the present storm water volume. Upgrade of this stormdrain system should be a top priority. An assessment of possible BMPs both in the upstream watershed and on Unit lands to reduce the amount of sediment entering the Marina basin should be implemented.

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